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5. NATURE AND EXTENT OF CHEMICAL CONSTITUENTS EXCEEDING REGULATORY CRITERIA

This chapter provides a description of the nature and extent of chemical constituents detected in environmental media at the Landsburg Mine site. The primary purpose of this chapter is to identify the chemical compounds *resulting from waste disposal activities conducted at the mine* which potentially pose a human or environmental health risk and/or which exceed potential regulatory criteria. The compounds which are identified as such are termed the contaminants of concern (COC). The COC are identified for each media which represent a potential chemical exposure route and are chosen through a step-wise screening process which considers laboratory and field blank data, background concentrations, appropriate regulatory criteria, and other considerations. The data evaluation performed in this chapter is based on regulatory guidelines presented in WDOE (1992, 1993b, 1994, and 1995).

5.1 Approach

The overall aim of the screening is to identify the COCs, i.e. the compounds which exceed ARARs *and* are the result of waste disposal activities at the mine. The approach conducted herein to identify the COCs consists of the following steps:

- **Analytical data validation.** Data validation is a task related to quality assurance which validates the overall correctness and accuracy of the analytical data obtained in the RI. The result is a database of analytical results which have been confirmed through a standard data validation procedure and which are considered useable for decision making purposes;
- **Comparison of analytical data to ARARs.** Once a validated database has been compiled, the data are then compared to the chemical-specific regulatory criteria (ARARs) defined in Chapter 4 to identify which compounds pose a potential risk to human health and/or exceed regulatory criteria. The compounds which exceed the regulatory screening criteria are retained for further consideration in the screening process. Compounds which do not exceed regulatory screening criteria are eliminated from further considerations in this RI.

It is important to note that site data are usually compared to background levels prior to comparisons to regulatory criteria. However, in the case of this RI, it was not practicable to define site-specific background for much of the data (groundwater and surface water). For groundwater for instance, this was because of the large number of different hydrostratigraphic units which were monitored by the site monitoring wells and private wells each of which would have required its own definition of background. Given this fact, the regulatory comparison was performed first in order to reduce the total number of compounds retained in the screening. Any background comparisons which could be made were then made on the reduced list of compounds.

- **Consideration of other factors and criteria to identify the Contaminants of Potential Concern (COPC).** The next step in the screening process consists of the consideration of other criteria, such as background data (if available), field and trip blank detects, and the consistency of detection to further refine the retained list of compounds. The resulting list is termed the Contaminants of Potential Concern (COPC). COPC are defined for each media and represent those compounds which exceed the regulatory screening values and whatever background data are available for the site. It is important to note, however, that the COPC do not necessarily represent compounds resulting from mine waste disposal activities since site-specific background data are limited (such as for groundwater).
- **Identification of Contaminants of Concern (COC).** The final step of the screening consists of the identification of the Contaminants of Concern (COC). This is performed by considering groundwater quality typical of coal mines in the State of Washington to identify those COPCs, if any, which are actually believed to have resulted from waste disposal in the Rogers seam. Coal mine water quality data are used because of the lack of site-specific background data for groundwater. The COCs represent those chemicals in environmental media at the site which exceed regulatory criteria *and* are believed to be the result of waste disposal rather than just natural background conditions.

This step-wise screening process is presented below in Section 5.2. Section 5.3 describes the distribution throughout the Study Area of the various media-specific COPC identified in Section 5.2. Section 5.4 identifies the COC and summarizes the major conclusions of this chapter.

5.2 Data Screening

5.2.1 Media Addressed

The *Conceptual Model of the Landsburg Mine Site* (Golder 1992b) identified exposure to contaminated soil and groundwater as the primary exposure pathways which needed to be evaluated in this RI. Airborne and surface water contamination were also identified as potentially significant exposure pathways, however, these were designated as secondary pathways and were not considered as significant as the soil and groundwater pathways. The scope of work outlined in the Work Plan (Golder 1992a) was therefore aimed at evaluating chemical occurrences in these four media. As discussed in Chapter 2, data collection activities for these media consisted of the following:

- air monitoring data collected along the trench bottom in a series of three site walk-throughs and during drilling for health and safety purposes;
- four quarters of groundwater sampling from seven newly installed site monitoring wells and 14 existing private wells (round 4 sampling was performed on a reduced set of 7 wells);

- four quarters of surface water sampling from the two mine portals (portals #2 and #3); and
- surface soil sampling in three areas of the site: the trench rim, portals #2 and 3, and test pit locations.

These are the data which will be screened in this sub-section. In addition to these data, the screening will also address soil contaminant data collected within the trench itself during the SHA (E&E 1991) and ERA (Landsburg PLP Steering Committee 1991). Summaries of the data collection activities conducted as part of this RI are included in Chapter 2. Tables 2-2 and 2-3 summarize the number of soil, groundwater and surface water samples collected in this RI and analyses performed, as well as other pertinent sampling information. Complete summaries of all soil, groundwater and surface water data are included in Appendix C.

The screening process conducted here is not applied to the air monitoring data. Air regulatory criteria are chemical-specific in nature. The air data collected, however, consist of *total* volatile organics concentrations, as measured by field monitoring instrumentation. Rather than comparing these data to regulatory criteria, the data will be used qualitatively (in Section 5.3) to assess the overall significance of the air pathway as a potential exposure route.

It is important to note that, as indicated in Chapter 2, the approach taken during the RI was to focus environmental sampling efforts on potential pathways of chemicals leaving the mine. As such, the RI did not include sampling of the Cedar River.

5.2.2 Data Validation

The first step in the data evaluation process consists of data validation. Data validation was conducted for all laboratory chemical analyses conducted as part of this RI, i.e. all soil, groundwater and surface water chemical testing. Laboratory data validation was conducted in accordance with guidelines presented in Bleyler (1988a,b), the Quality Assurance Project Plan (QAPP) (Golder 1992a) and Golder technical procedure TP-2.2-3, "Analytical Data Validation and Data Management". Table 5-1 summarizes the results of data validation for the RI chemical data.

Data validation was conducted by Golder chemistry personnel who, upon receipt of data packages from the analytical laboratory, conducted a detailed review and calculation overcheck process to ensure that the laboratory met all contractual requirements, all applicable reference method requirements, and the data quality objectives specified in the QAPP.

A separate data validation report was prepared for each sample delivery group (SDG). An SDG is defined in this RI as a group of samples delivered to a lab under a single chain-of-custody. As seen in Table 5-1, there were a total of 33 SDGs for this RI. Each data validation report documents the evaluation of laboratory blanks, duplicates, matrix spike/matrix spike duplicates, laboratory control samples, calibration data, and any requalification of analytical results that was required as part of the data validation exercise. All data validation reports are routed to the permanent project records file, as required by the Data Management Plan (Golder 1992a). Permanent records are maintained at Golder's offices in Redmond, WA.

As shown in Table 5-1, the DQOs defined in the QAPP for analytical data were generally attained, with a few minor deficiencies which are noted in the table. Overall, between 99 and 100% of the total number of requested analytical determinations were determined to be valid which exceeds the goal established in the QAPP of 90% for a given SDG.

It is important to note that, while the data validation process did include adjustments (requalifications) to the data on the basis of laboratory (method) blank data, such adjustments were not made on the basis of detects observed in field or trip blanks. This is not normally included as part of data validation. Detects in field or trip blanks could be indicative of sample contamination which occurred in sample transit or as a result of sampling procedures. Consideration of any required adjustments on the basis of field or trip blank data will be made in Section 5.2.4. Field and trip blank sample IDs collected for each SDG are shown in Table 5-1. All detects in field and trip blank samples are summarized in Table 5-2.

5.2.3 Comparison to Potential ARARs (Screening)

The next step in the screening process is to compare the analytical results validated above in Section 5.2.2 to relevant regulatory criteria (ARARs). The determination of potential ARARs for the Landsburg Mine site, including action- and location-specific ARARs as well as the chemical-specific ARARs, is given in Chapter 4. The reader is referred to Chapter 4 for a detailed discussion of the federal, state and local laws considered potentially ARAR for this site. Compliance with ARARs is a requirement of MTCA (WAC 173-340-710).

The following chemical-specific laws and regulations are considered to be the primary ARARs to consider for the Landsburg site:

Groundwater	MTCA (WAC 173-340) and the federal Primary and Secondary Drinking Water Regulations (40 CFR 141 and 143)
Surface Water	MTCA (WAC 173-340) and the State Surface Water Quality Criteria (WAC 173-201A)
Soil	MTCA (WAC 173-340)

These are the criteria utilized in the regulatory screening conducted herein. The procedure used in the screening is to compare the maximum value for each detected compound to the ARAR concentration limit for that medium. When multiple potential ARARs exist for a particular compound, the minimum ARAR value is used in the screening. A complete listing of the groundwater, surface water and soil ARARs is presented in Tables 4-3, 4-4, and 4-5, respectively.

It is important to note that the use of these potential ARARs is not to be considered an acknowledgment by the PLP Group of the applicability of a particular law or regulation to remedial actions conducted at the Mine. For instance, there is some uncertainty as to the applicability of the State Surface Water Quality Criteria and the MTCA surface water requirements to the surface water samples (portals) collected as part of the RI. These ARARs are

utilized in the screening, however, to present all of the potential ARARs for comparison purposes.

Compounds detected in site monitoring wells and Study Area private wells for the four sampling rounds are summarized in Tables 5-3 and 5-4, respectively. The chemical-specific regulatory screening concentrations are also listed in the tables. Detected concentrations in surface water and the associated screening values are shown in Table 5-5. Tables 5-6, 5-7 and 5-8 summarize the compounds detected in trench rim soils, portal soils, and backhoe test pit soils, respectively, along with the regulatory screening values. Table 5-9 summarizes the compounds detected along the bottom of the trench as part of the SHA and ERA, along with regulatory screening values. Exceedance of a screening value is indicated by shading in the tables. Exceedance of a screening value at this point in the screening does not necessarily indicate a significant human or environmental health hazard, but only the need to retain the compound for further consideration.

5.2.3.1 Groundwater

Monitoring Wells. Compounds detected in site groundwater monitoring wells and the associated regulatory screening values are summarized in Table 5-3. As seen in the table, constituents which exceed the screening values consist of aluminum, iron, manganese, thallium, and total dissolved solids (TDS). One organic compound was detected (1,2-dibromo-3-chloropropane [DBCP]), however, the 2 detected values (both at 0.025 $\mu\text{g/L}$) did not exceed the minimum potential regulatory criteria (0.0312 $\mu\text{g/L}$) and the compound is not considered further.

Aluminum was detected at a maximum concentration of 140 $\mu\text{g/L}$ versus the screening value of 50 $\mu\text{g/L}$. Iron was detected at a maximum value of 2,230 $\mu\text{g/L}$ versus a screening value of 300 $\mu\text{g/L}$. Manganese was detected at a maximum value of 299 $\mu\text{g/L}$ versus a screening value of 50 $\mu\text{g/L}$. Thallium was observed at a maximum concentration of 2 $\mu\text{g/L}$ versus a screening value of 0.5 $\mu\text{g/L}$, and TDS was measured at a maximum value of 780,000 $\mu\text{g/L}$ versus a screening value of 500,000 $\mu\text{g/L}$. Apart from thallium, all of these screening values consist of Secondary Maximum Contaminant Levels (SMCLs). SMCLs are not health-based standards, but are protective of aesthetic qualities of water only. The screening value for thallium is a Maximum Contaminant Level Goal (MCLG) value specified under federal drinking water standards. The MTCA Method B standard for manganese of 80 $\mu\text{g/L}$, while not the minimum ARAR for the compound, was also exceeded in some instances in addition to the SMCL.

Private Wells. Compounds detected in the Study Area private wells and the associated regulatory screening values are summarized in Table 5-4. As seen in the table, constituents which exceed the screening values consist of aluminum, arsenic, iron, lead, manganese, thallium, and pH. Several organic compounds were detected in the private wells. Of these, one compound, bis(2-ethylhexyl)phthalate, exceeds potential regulatory criteria.

Aluminum was detected at a maximum concentration of 2,560 $\mu\text{g/L}$ vs the screening value of 50 $\mu\text{g/L}$. Arsenic was detected at a maximum value of 19 $\mu\text{g/L}$ vs the screening value of 5 $\mu\text{g/L}$. Iron was detected at a maximum value of 5,400 $\mu\text{g/L}$ vs a screening value of 300 $\mu\text{g/L}$. Lead was observed at a maximum concentration of 16 $\mu\text{g/L}$ as compared to the regulatory screening

concentration of 5 $\mu\text{g/L}$. Manganese was detected at a maximum value of 416 $\mu\text{g/L}$ vs a screening value of 50 $\mu\text{g/L}$. Thallium was observed at a maximum concentration of 3 $\mu\text{g/L}$ as compared to a screening value of 0.5 $\mu\text{g/L}$. Bis(2-ethylhexyl) phthalate was observed at a maximum level of 6.7 $\mu\text{g/L}$ vs a screening value of 6 $\mu\text{g/L}$, and pH was measured at levels below the minimum pH value of 6.5 and above the maximum value of 8.5. The screening values for aluminum, iron, manganese, and pH all consist of SMCLs. The screening values for arsenic and lead are MTCA Method B values, and the screening value for bis(2-ethylhexyl)phthalate is an MCL value. The screening value for thallium is an MCLG. As with the monitoring wells, the Method B standard for manganese of 80 $\mu\text{g/L}$, while not the minimum ARAR for the compound, was also exceeded in some instances in addition to the SMCL.

Table 5-10 summarizes the compounds exceeding potential ARARs in all groundwater samples, including the maximum detected values, screening values, number of samples, number of detected values, mean concentrations and number of samples exceeding the screening value. This list of compounds exceeding ARARs for monitoring wells and private wells is evaluated further below in Section 5.2.4 to arrive at the COPC for groundwater.

5.2.3.2 Surface Water

Compounds detected in surface water samples collected as part of the RI and the associated regulatory screening criteria are presented in Table 5-5. As seen in the table, one compound, arsenic, was identified as exceeding a potential surface water ARAR. Arsenic was detected at a maximum concentration in surface water of 3 $\mu\text{g/L}$ vs a screening value of 0.0842 $\mu\text{g/L}$. The arsenic ARAR consists of a Method B cleanup level for surface water.

Table 5-11 summarizes the compounds exceeding potential ARARs in surface water. This list of compounds is evaluated further below in Section 5.2.4 to arrive at the surface water COPC.

5.2.3.3 Soil

Compounds detected in trench rim soils, portal soils, backhoe test pit soils and from within the trench itself along with the associated regulatory screening values are presented in Tables 5-6, 5-7, 5-8, and 5-9, respectively. As seen in the tables, compounds exceeding potential ARARs outside of the trench include arsenic (for trench rim soils, portal soils, and test pit soils), and beryllium (for trench rim soils and test pit soils). For materials inside the trench (soils and sludge) sampled as part of the SHA and ERA, compounds exceeding potential ARARs include arsenic, chromium, lead, PCBs and bis(2-ethylhexyl)phthalate (for trench soils) and methylene chloride, TCE, TPH and PCBs (for the sludge pond). A number of organic compounds were detected in soils both inside and outside of the trench; however, no organic compounds detected outside the trench exceeded any potential regulatory criteria.

In the trench rim soils, arsenic was detected at a maximum concentration of 16 mg/kg versus a regulatory screening level of 7 mg/kg. Beryllium was detected at a maximum value of 1 mg/kg versus the regulatory screening value of 0.23 mg/kg. Arsenic was detected at a maximum value of 26 mg/kg in the portal soils and a maximum concentration of 11.4 mg/kg in the test pit soils versus a screening value of 7 mg/kg. Beryllium in the test pit soils was detected at a maximum value of 0.8 mg/kg. All of these screening values represent Method B values.

For soils inside the trench, arsenic was detected at a maximum value of 19 mg/kg versus a screening value of 7 mg/kg. Lead was detected at a maximum concentration of 3200 mg/kg versus the screening value of 250 mg/kg. Chromium was detected at a maximum value of 912 mg/kg versus a screening value of 400 mg/kg. Aroclor-1242 and -1254 were detected at maximum values of 7.9 mg/kg and 27.2 mg/kg, respectively, versus a regulatory screening value of 1.6 mg/kg. Bis(2-ethylhexyl)phthalate was detected at a maximum value of 178 mg/kg versus a screening value of 71.4 mg/kg.

For the pond sludge sample, methylene chloride was detected at a concentration of 1690 mg/kg versus a screening value of 133 mg/kg. TCE was detected at 1530 mg/kg vs. 90.9 mg/kg. TPH was observed at 67,000 mg/kg versus a screening value of 200 mg/kg, and PCBs were detected at a concentration of 4.9 mg/kg versus 1.6 mg/kg. All of these screening values are Method B values except for TPH which is a Method A.

Table 5-12 summarizes the compounds exceeding potential ARARs for soils. This list of compounds is evaluated further below in Section 5.2.4 to arrive at the soil COPC.

5.2.4 Consideration of Other Criteria

In this section, additional screening criteria, including background concentrations (when available), consistency of detection, and field blank results, are applied to define the lists of COPC. The aim is to eliminate results which are detected inconsistently, or are indicative of background levels or sample contamination, so that these data are excluded from consideration in the RI.

5.2.4.1 Field and Trip Blank Data

The purpose of conducting chemical analyses on field and trip blank samples is to eliminate sample detects which may have resulted from sample contamination. Such contamination could occur during sample transit or as a result of improper or inadequate sample collection procedures. The purpose of this section is to check whether any of the compounds identified above can be eliminated on the basis of field or trip blank data.

Per Bleyler (1988a,b), sample detects (in actual samples rather than blank samples) which fall below calculated blank adjustment factors are adjusted to non-detects. Blank adjustment factors are calculated by multiplying the detected concentration in the blank sample by a factor of 5 or 10, depending on the compound. The resulting blank adjustment factor is then compared to the analytical results associated with the SDG (see Section 5.2.2 for SDG definition). Any detected value which is less in magnitude than the blank adjustment factor is considered a non-detection.

Detected values observed in field and trip blank samples collected as part of this RI are summarized in Table 5-2. All of the field or trip blank samples are associated with groundwater samples. In comparing the compounds detected in blanks in each of the SDGs versus the list of compounds exceeding ARARs for groundwater, it is apparent that no maximum detected values for these compounds fall below any blank adjustment factors. Therefore, no adjustments can be made on the basis of field or trip blank data.

5.2.4.2 Consistency of Detection

Several compounds exceeding ARARs, all of which are for groundwater, can be eliminated because they were detected very inconsistently. The consistency of detection for these compounds was so low that the presence of the compounds in the site groundwater is highly questionable, and it is therefore not reasonable for the compounds to be retained in this screening. These compounds include the following:

For monitoring wells:

- thallium

For private wells:

- thallium
- bis(2-ethylhexyl)phthalate
- lead.

In the case of the monitoring wells, thallium was detected only 5 times out of 28 samples (Table 5-10). The maximum value of $2\text{ }\mu\text{g/L}$ was only very slightly above the regulatory screening value of $0.5\text{ }\mu\text{g/L}$. All of the detects were very close to the detection limit of $1\text{ }\mu\text{g/L}$. There were no detects in round 3 and only 1 detect in round 4. Only at one well (LMW-2) was there more than 1 detect over the four rounds.

For private wells, there was only a single detected value of thallium in round 1, and there were no detects in rounds 3 and 4. The maximum concentration ($3\text{ }\mu\text{g/L}$) only very marginally exceeds the screening value of $0.5\text{ }\mu\text{g/L}$ and the detection limit of $1\text{ }\mu\text{g/L}$. The maximum value for thallium ($3\text{ }\mu\text{g/L}$) was detected at a well (PW-8) which is hydraulically isolated from the mine. There is therefore no observable pathway for the compound to have migrated from the mine to the well (see Section 3.6.4.1).

Bis(2-ethylhexyl)phthalate was detected only twice in 49 samples. Only a single sample exceeded the screening value. The one exceedance ($6.7\text{ }\mu\text{g/L}$) was by a very slight margin (screening value of $6\text{ }\mu\text{g/L}$). The compound was not detected in any mine site wells. None of the detects were repeated more than once at a well. The detect at well PW-5 occurred in a well that is hydraulically isolated from the mine. The compound is a common laboratory contaminant.

Lead was detected at levels above the screening level at only 2 of 49 samples. At the two wells where the exceedances occurred, three of the four other results were ND with one result of only $1\text{ }\mu\text{g/L}$. The maximum value for lead ($16\text{ }\mu\text{g/L}$) was detected at a well (PW-15) which is hydraulically isolated from the mine.

Because of the inconsistent nature of the detects, the very low values and the lack of observable pathways from the mine, it is not reasonable to carry these compounds forward in the screening. Therefore, they are eliminated from further consideration.

5.2.4.3 Background Data

It is not possible to perform any background screening on groundwater or surface water media at the site due to an absence of adequate site-specific or area background data. However, it is possible to conduct background screening for metals in soil, as described below.

The requirements under MTCA for determining natural background concentrations for chemicals in soil are provided in WAC 173-340-708 (11). Two types of background may be determined: an "area" and "natural". The derivation of natural background requires the collection of at least 10 samples, while derivation of area background requires at least 20 samples. Since fewer than this number of samples were collected as part of this RI which could be considered representative of background, a site-specific assessment of background for the Landsburg Mine site soils was not performed.

In lieu of site-specific determinations, however, information provided in a recently published Ecology report can be used. *Natural Background Soil Metals Concentrations in Washington State* (WDOE 1994) defines a range of values that represent the natural concentrations of metals in surficial soils throughout Washington. State-wide and regional 90th percentile values are presented. There are no restrictions on the use of the state-wide values. These can be used for comparison against data collected from any site in the State. The regional values are to be compared against data from those regions only.

The state-wide 90th percentile values for beryllium, arsenic, chromium and lead are shown in Table 5-13. When comparing site data vs background, the 95% upper confidence limit (UCL) of a given data set is compared against the 90th percentile of the background data set, per WDOE (1992). As seen in the table, the maximum detect and the 95% UCL for beryllium (for trench rim soils and test pit soils) are less than the 90th percentile value. Beryllium can therefore be eliminated for soil.

With respect to arsenic, the maximum detected values at each of the areas sampled and the calculated UCL values exceed the reported arsenic background value of 6.99 mg/kg. UCL values were calculated of 8.47 mg/kg, 15.28 mg/kg and 11.87 mg/kg for the trench rim soils, portal soils, and test pit soils, respectively. Maximum concentrations for these areas are only 16 mg/kg, 26 mg/kg, and 11.4 mg/kg, respectively. The maximum level in the trench soils is 19 mg/kg. Despite the fact that the maximum levels and the UCLs for these areas exceed the reported background concentration, however, these levels of arsenic do not suggest arsenic contamination in the soil, but rather a site-specific arsenic background which is elevated over the reported background value for the state. As seen in Tables 5-6, 5-7, 5-8 and 5-9, the arsenic levels observed throughout the various sampling locations are quite uniform, ranging from a minimum of 4 mg/kg to only 26 mg/kg. If arsenic contamination was indeed present, the data would be less uniform and likely contain isolated instances of much higher arsenic levels. The fact that these "spikes" do not exist suggests that the levels represent the area background and not contamination. In addition, the sample collected near the Frasier seam portal (sample FNS-1, Table 5-7), away from potential contamination associated with waste disposal, exhibits one of the highest arsenic levels measured at the site (18.4 mg/kg). All of the measured arsenic levels at the site are within the range (0.5 to 28.6 mg/kg) of the reported state-wide background samples.

Therefore, for these reasons the arsenic measured in the soil is not considered to represent contamination, but rather, the area background and arsenic is eliminated from further consideration.

The maximum detected values for lead (3,200 mg/kg) and chromium (912 mg/kg) are significantly elevated over their respective background values of 17.09 mg/kg and 41.83 mg/kg. These two compounds cannot therefore be eliminated. It is not possible to calculate a UCL value for the lead and chromium since only a single sample was collected at each sampling area. However, there was only a single exceedance of the lead and chromium screening values, and it was for one sample (sample location LS-8) collected within the trench (see Figure 3-4).

5.2.4.4 Lists of COPC

Therefore, on the basis of the additional screening considerations presented above a number of compounds listed in Tables 5-10, 5-11 and 5-12 are eliminated. For groundwater, thallium is eliminated from the monitoring well screening group, and thallium, lead, and bis(2-ethylhexyl)phthalate) are eliminated from the private well screening group. For soils, arsenic and beryllium are eliminated from all soils. For surface water, no compounds were eliminated. The list of COPC therefore consists of the following:

GROUNDWATER

Monitoring Wells

- aluminum
- iron
- manganese
- total dissolved solids

Private Wells

- aluminum
- arsenic
- iron
- manganese
- pH

SURFACE WATER

- arsenic

SOIL

- chromium (trench only)
- lead (trench only)
- bis(2-ethylhexyl)phthalate (trench only)
- PCBs (trench only)
- methylene chloride (trench only)
- TCE (trench only)
- TPH (trench only)

5.3 Extent Of Contaminants of Potential Concern (COPC)

The purpose of this section is to describe the distribution throughout the site and Study Area of the COPCs. A primary focus will be on assessing whether any of the observed chemicals in groundwater or surface water are related to the prior waste disposal activities conducted at the site. In addition, the results of the air monitoring survey, which were not screened vs. ARARs as with the other media, are presented. Air monitoring data were not screened against ARARs because the air data were in terms of total organics, and regulatory criteria are generally chemical-specific.

5.3.1 Air

Air monitoring conducted in this RI consisted of three surveys through the mine trench and health and safety monitoring conducted during drilling activities. The performance of the surveys through the mine trench is described in Section 2.1. Figure 2-1 depicts the locations of the surveys. Results of the three surveys are summarized in Tables 5-14, -15 and -16.

As seen in the table, the levels of volatile organics measured in the trench were generally non-detectable or indistinguishable from background. Several readings taken at various locations within the trench registered up to 1 ppm on the OVA; however, these readings are more indicative of instrument drift or background than the actual detection of any organic vapors.

The only location where detectable levels were observed consists of the “sludge pond” in the trench to the north of the LMW-1 access road. At this location, readings ranged up to 3.1 ppm. This pond is known to contain organic chemicals on the basis of the sampling performed as part of the ERA (Landsburg PLP Steering Committee 1991). The extent of these emissions is quite limited, however, as the measurements fell to non-detectable values within a short distance (approximately 20 ft) on either side of the pond.

Air monitoring data conducted during monitoring well drilling were recorded on Air Monitoring Data Sheets and are maintained in the project file. This monitoring was conducted for health and safety purposes and consisted of periodic readings around the drill rig (breathing zone, over borehole, and at cyclone discharge) using a Microtip photo-ionization detector (PID). Readings were taken at approximately 15 to 60 minute intervals. The results of this monitoring indicated generally non-detect values at all locations monitored. Very occasional spikes were

noted in the 1 to 10 ppm range. These spikes were brief and may have been the result of water vapor (mist) used in the drilling as PID instruments are sensitive to the presence of moisture.

These results are consistent with the results of the soil gas survey performed at the site in 1990 (Applied Geotechnology 1990) which did not find detectable concentrations of VOCs in the trench.

5.3.2 Groundwater

This sub-section will describe the distribution of the various groundwater COPC identified earlier in Section 5.2.4. The primary aim is to assess whether the prior waste disposal practices at the mine have contributed to the observed groundwater concentrations or if the distribution of chemicals which is observed is the result of naturally occurring background conditions. Figures 5-1 and 5-2 depict the quarterly results of COPC at monitoring wells and private wells, respectively.

5.3.2.1 Distribution of COPC

Aluminum. Aluminum was detected sporadically throughout the Study Area with detects occurring in 12 of the 21 wells sampled. The compound was measured at concentrations up to 2560 $\mu\text{g/L}$, however, except for this one value, no detects exceeded 140 $\mu\text{g/L}$. The maximum detected values occurred at wells LMW-6 (140 $\mu\text{g/L}$), LMW-7 (100 $\mu\text{g/L}$), PW-5 (120 $\mu\text{g/L}$), PW-7 (90 $\mu\text{g/L}$) and PW-15 (2560 $\mu\text{g/L}$). Regulatory criteria for aluminum includes a SMCL of 50 $\mu\text{g/L}$ and a Method B standard of 16,000 $\mu\text{g/L}$.

There is little spatial regularity to the observed distribution of aluminum in the Study Area. Occurrences of the compound, however, appear to be related to wells installed within coal or other materials of the Puget Group. Significant aluminum concentrations were not detected in any of the wells installed around the perimeter of the Study Area in the glacial outwash deposits (PW-3, -9, -10, -12, and -13, for instance). The higher values were noted at LMW-6 and LMW-7, and in PW-5 and PW-15. Each of these wells, with the possible exception of PW-15, is installed directly in coal (Figure 3-11). The well construction for PW-15 is not known; however, it is probable that the well is completed within the Puget Group given its location and depth (140 to 150 ft). Each of these wells is hydraulically isolated from the mine (Section 3.6.4.1).

Another important factor which may be contributing to the observed aluminum occurrences is related to sample turbidity. As discussed in Chapter 2, analysis for metals was performed on unfiltered samples (except for LMW-1). Immediately upon sample collection the samples were preserved by acidification. This procedure can result in elevated metals results if sediment is present in the sample. Sample acidification will tend to drive into solution any metals which are present in sediment particulates (either sorbed or as precipitate). Metals commonly sorb to negatively charged clay particles since they are positively charged.

Field turbidities measured at each well during the four sampling rounds are summarized in Table 5-17. These values are plotted vs the measured aluminum results in Figure 5-3. The data shown suggest a relationship between sample turbidity and the measured aluminum values. All

of the higher aluminum levels (greater than about 50 $\mu\text{g/L}$) were also characterized by turbidity levels in excess of 1 NTUs. In contrast, aluminum levels were generally very low (less than 50 $\mu\text{g/L}$) in wells with turbidities less than 1 NTU. In the Rogers Seam wells, aluminum was detected only at LMW-3. This is also the well which displayed the highest turbidity levels of the five Rogers Seam wells (except for LMW-1, where samples were filtered due to excessive turbidity). This observed relationship between turbidity and aluminum concentration suggests that a major component of the observed aluminum concentrations consists of a sorbed phase which was driven into solution as a result of sample preservation and which would not normally be mobile in groundwater.

Arsenic. Arsenic was detected sporadically in the Study Area with detects occurring in ten of the 21 wells. The maximum detected value was 19 $\mu\text{g/L}$ (PW-8). The MCL for arsenic is 50 $\mu\text{g/L}$ and the Method B cleanup level is 5 $\mu\text{g/L}$ (based on a State of Washington background value [WAC 173-340-720, Table 1, footnote b]). Only five detected values exceeded the 5 $\mu\text{g/L}$ regulatory value. These values occurred at only three wells (PW-7, -8 and -15). Similar to aluminum, there is little spatial regularity to the distribution of the compound throughout the Study Area, except that it appears to occur in association with coal and/or other rocks of the Puget Group. There were no detects in the outwash wells around the perimeter of the Study Area. Also, as with aluminum, there were no regulatory exceedances in any of the monitoring wells installed at the mine. The maximum values of arsenic occurred at wells (PW-7, -8 and -15) which are hydraulically isolated from the mine (Section 3.6.4.1). There is no pathway for chemicals to migrate to these wells from the mine.

Iron. Iron is very prevalent throughout the Study Area with detects in all but 2 wells (PW-9 and -13). The maximum value observed is 5400 $\mu\text{g/L}$. The iron SMCL is 300 $\mu\text{g/L}$. There are no other regulatory criteria for iron. In contrast to arsenic and aluminum, iron is observed at levels in excess of the regulatory limit in the Rogers Seam monitoring wells. In fact, levels are relatively high in these wells as compared to elsewhere in the Study Area (1360 $\mu\text{g/L}$ at LMW-4 and 1200 $\mu\text{g/L}$ at LMW-2). Higher values occur at LMW-6 (2300 $\mu\text{g/L}$), PW-6 (2040 $\mu\text{g/L}$), PW-15 (5400 $\mu\text{g/L}$) and PW-7 (4000 $\mu\text{g/L}$). As with the other compounds, the wells installed in the outwash deposits are generally low in iron (less than 200 $\mu\text{g/L}$ in general). There is, again, little discernible spatial pattern to the occurrence of the iron except that it is associated with the wells installed in Puget Group materials. The maximum values for iron occurred in wells (LMW-6, PW-6, PW-7 and PW-15) which are hydraulically isolated from the mine.

The observed relationship between iron and field turbidity is shown in Figure 5-3. While there may be some affect on the reported iron concentrations due to turbidity, the dependence is not as definite as with aluminum. A number of samples with very low turbidity (less than 1 NTU) exhibit quite high iron levels. Therefore, while turbidity may contribute somewhat to elevated iron levels, the occurrence of iron cannot be attributed to the presence of sediment as with the case of aluminum.

Manganese. The observed distribution of manganese is very similar to iron. The maximum value observed is 416 $\mu\text{g/L}$ (PW-7) as compared to the SMCL of 50 $\mu\text{g/L}$ (and the MTCA Method B value of 80 $\mu\text{g/L}$). Exceedances of the screening limit occur in the Roger seam wells, as with iron (LMW-1 to -5) with a maximum value in these wells of 280 $\mu\text{g/L}$ (LMW-4). Comparable or higher values occur in LMW-7 (299 $\mu\text{g/L}$) and PW-7 (416 $\mu\text{g/L}$). Other regulatory exceedances

include PW-4 (54 $\mu\text{g/L}$), PW-15 (99 $\mu\text{g/L}$), and PW-6 (55 $\mu\text{g/L}$). The relationship between turbidity and observed manganese levels is also similar to that with iron, and is shown in Figure 5-3.

Total Dissolved Solids. Total dissolved solids range up to 780,000 $\mu\text{g/L}$ (LMW-4). The only regulatory limit for TDS consists of a SMCL of 500,000 $\mu\text{g/L}$. The highest values of TDS are associated with the LMW wells with exceedances of the SMCL occurring at LMW-1, LMW-2, LMW-4 and LMW-5. Levels in private wells are lower and range from about 50,000 $\mu\text{g/L}$ in the wells located around the perimeter of the Study Area to 333,000 $\mu\text{g/L}$ at PW-14, 208,000 $\mu\text{g/L}$ at PW-6, and 201,000 $\mu\text{g/L}$ at PW-4. No private wells exceeded the SMCL for TDS.

In summary, while some compounds do exceed regulatory limits in the Mine vicinity and Study Area, there is little spatial regularity or pattern to the distribution of groundwater constituents which would suggest the Mine is the source of these compounds. The presence of aluminum in Study Area groundwater, which was not detected to any significant extent in the Rogers Seam wells, appears to be related to levels of turbidity in unfiltered samples. Arsenic was detected at very low levels in only a few isolated occurrences. The compound occurred in only one of the five Rogers Seam wells (LMW-1). Neither aluminum nor arsenic exceeded a regulatory standard in any of the mine wells. Iron and manganese, which occur very prevalently throughout the Study Area, occur at their highest levels in wells which are hydraulically isolated from the Mine (LMW-6, LMW-7, PW-5, PW-6, PW-7 and PW-15). There is no observable pathway for chemicals to migrate from the mine to these wells.

The indication, therefore, is that compounds identified as COPC in groundwater occur naturally at the site at levels which happen to be above regulatory limits. This is consistent with information reported elsewhere regarding the water quality of coal mine drainage and groundwater in contact with coal deposits. This is discussed below in Section 5.3.2.2.

5.3.2.2 Water Quality Typical of Coal-Mine Drainage

The USGS studied coal-mine drainage at approximately 100 abandoned coal mines in Western Washington to characterize the water quality of drainage from abandoned mines in the 11 coal-bearing areas of the state (Fuste et al. 1983). Table 5-18 presents a summary of the mean concentrations and ranges of values for selected water-quality parameters measured in the study. For comparative purposes, data collected from this RI, consisting of averages of the monitoring well and portal surface water data, are also shown in the table. The monitoring well and portal surface water data are used here (and not the private well data) since these represent the data most comparable to that reported for coal-mine drainages.

As seen in the table, the mean and maximum values measured at the Mine are generally consistent with the values reported in the USGS study. Exceptions include aluminum and manganese where the maximum values for the site are outside the range reported by Fuste et al. (1983). However, for both of these compounds, the mean values fall within the reported ranges. It must be noted that the data from the USGS study represent only the dissolved constituents while the Landsburg data represent "total" quantities, i.e. the dissolved portion plus any portion sorbed to sediment which may be present in the sample.

The comparison of the two data sets therefore indicates that the quality of groundwater at the Mine is typical of water-quality observed at other coal mines throughout the State of Washington.

Other available information indicates that coal-bearing materials are apparently common sources for iron and manganese in groundwater and surface water. Fuste and Mayer (1987) report on the quality of water in ten streams located in two coal-bearing areas in southwest Washington. The purpose of the study was to investigate the effects of strip mining for coal on surface water quality. In the study, consistently higher concentrations of iron, manganese, and zinc were found in the bottom sediments of streams located in the mined basins. Hem (1985) reported levels of iron in coal-mine drainage up to 15,000 $\mu\text{g/L}$ and indicated that manganese and iron are commonly present in streams receiving coal-mine drainage. Organic materials (i.e., coal) are identified in Hem (1985) as a common source of iron in groundwater.

Fuste and Mayer (1987) suggest a dependence on Eh and dissolved O_2 concentration for dissolved iron and manganese levels in water. Increased O_2 causes iron and manganese minerals to be oxidized and to precipitate out of solution. Low dissolved O_2 and an associated reducing environment can promote mineral dissolution and relatively high dissolved iron and manganese concentrations. This dependence on Eh is also indicated in Hem (1985), where it is stated that iron and manganese are highly dependent on the levels of oxidation or reduction. Where relatively low Eh can be maintained, and iron and manganese minerals are present, considerable iron and manganese concentrations can be attained.

Since the presence of organic matter (in coal for instance) can deplete O_2 levels in groundwater and lead to a chemically reducing environment, it is considered likely that the coal-bearing materials at the site naturally promote conditions which support relatively high iron and manganese concentrations in groundwater.

Finally, widespread excessive iron and manganese has been reported for the Puget Sound region (Turney 1986) in a compilation of regional groundwater quality data. Iron exceeded the SMCL of 300 $\mu\text{g/L}$ in 14% of all samples collected. Manganese exceeded the 50 $\mu\text{g/L}$ SMCL in 40% of all samples. These exceedances were attributed to natural occurrences of the two compounds. In general, the two compounds were found to correlate quite strongly with one another: the manganese standard was exceeded in almost every well where the iron standard was exceeded. High iron and manganese were thought to be due to low oxygen content which leads to a chemically-reducing environment. This tends to keep the two compounds in solution leading to high-iron and manganese waters.

5.3.3 Surface Water

Arsenic exceeds the method B standard for surface water at portal #3 and portal #2 (Table 5-5 and 5-11). Water emanating at the portals represents groundwater discharge. The concentration of arsenic measured at the portals is consistent with levels observed in mine groundwater, i.e. arsenic in the low $\mu\text{g/L}$ range. Because seepage water at the portals consists of mine groundwater discharge, and mine groundwater has been shown to exhibit natural

background levels and not to have been impacted by mine waste disposal activities, these surface water exceedances of arsenic also represent a natural background condition.

5.3.4 Soil

For soils outside the trench, no compounds were identified as a COPC for soil (Section 5.2.4.4). Within the trench, chromium, lead, PCBs, bis(2-ethylhexyl)phthalate, methylene chloride, TCE and TPH exceeded regulatory criteria. These exceedances were associated with soil sampling conducted as part of the SHA, and pond sludge sampling performed during the ERA. For the soils, the exceedances were confined to two samples (LS-8 and LDS-1). These samples are both associated with the northern portion of the trench (Figure 3-4) where prior disposal is thought to have occurred. The sludge pond exceedances were associated with a single sample taken to characterize contaminant levels in the sludge pond area.

5.4 Conclusions and Identification of COCs

On the basis of the information presented in this chapter the following conclusions can be drawn:

AIR

- Throughout nearly the entire trench, no volatile organic compounds were detected in air. Detectable levels of volatile organic compounds in air were restricted to one small area within the trench in the vicinity of the sludge pond. These levels are not expected to pose any significant health hazard.

GROUNDWATER

- Groundwater was sampled from 21 groundwater wells in the immediate vicinity of the Mine over four quarterly sampling rounds and analyzed for a wide variety of chemical constituents, including volatile and semi-volatile organics, metals, cyanide, PCBs and pesticides, and general chemical characteristics. The results indicate that no federal drinking water standards (Maximum Contaminant Levels) are being exceeded at the Mine site itself or amongst any of the private wells sampled in the Study Area. The Method B standard for arsenic ($5\text{ }\mu\text{g/L}$) was exceeded at three private wells (levels up to $19\text{ }\mu\text{g/L}$) and the Method B standard for manganese ($80\text{ }\mu\text{g/L}$) was exceeded at 5 monitoring wells (levels up to $299\text{ }\mu\text{g/L}$) and 3 private wells (levels up to $416\text{ }\mu\text{g/L}$).
- Secondary Maximum Contaminant Levels, which are not health based standards but are intended to be protective of aesthetic water qualities only, are exceeded for aluminum, iron, manganese, total dissolved solids and pH at a number of wells located throughout the Study Area, including both private wells and monitoring wells. SMCLs were exceeded at every monitoring well. Of the 14 private wells

sampled, seven of the wells had at least one exceedance of a SMCL over the four rounds of sampling. Iron is the most prevalent compound exceeding an SMCL.

- Although a few organic compounds were detected in wells sampled, all of the detects were very low and inconsistent (not repeated in more than a single round). In addition, none of the organic compounds exceeded any established regulatory standards, except for one instance of bis(2-ethylhexyl)phthalate, a common laboratory contaminant, which occurred slightly above the Method B standard in round 2 in a private well, but was not detected in either of the other two rounds. There is therefore no indication of organics contamination in groundwater at the mine.
- The distribution of COPC around the Study Area indicates that the Mine is not the source of these compounds. Maximum levels occur, in many instances, in wells which are hydraulically isolated from the Mine. Also, the levels observed at the Mine are consistent with reports in the literature which indicate that coal is a natural and well-known source for these chemical constituents. The levels observed fall within the range of values typical for coal-mine drainages in the State. Therefore, while SMCLs are exceeded for several compounds and a Method B cleanup level is exceeded for two compounds, the occurrence of these compounds is not related to prior waste disposal activities at the Mine, but rather to natural background levels typical of coal-bearing sediments. There are therefore no COCs for groundwater at the Landsburg Mine site.

SURFACE WATER

- Arsenic exceeded a Method B standard for surface water at portal #3 and portal #2. The levels observed are consistent with groundwater levels measured at the mine site. As discussed above, the occurrence of the arsenic in groundwater (and therefore surface water) is a result of natural background conditions. There are therefore no COCs for surface water at the site.

SOIL

- There are no identified COC for soils outside the trench. All potential regulatory exceedances for soils outside the trench can be attributed to background.
- Within the trench, chromium, lead, PCBs, bis-(2-ethylhexyl)phthalate, methylene chloride, TCE and TPH exceed background and Method B standards in an area confined to the northern portion of the trench where waste disposal is thought to have occurred in the past. Soil contamination was not noted outside this area. On the basis of limited sampling conducted to date, however, and in conjunction with historical information and geophysics, potential contamination is believed to be restricted to the northern portion of the trench.

Therefore, apart from soils within the trench located in the area of known prior waste disposal activities, soil, groundwater and surface water media in the Study Area do not exhibit

concentrations of chemical constituents above naturally occurring background levels. The COCs for the Landsburg Mine site consist of the following:

Media	Contaminants of Concern
Groundwater	None
Surface Water	None
Air	None
Soils	
Outside Trench	None
Inside Trench	Chromium Lead PCBs TPH bis(2-ethylhexyl)phthalate methylene chloride TCE